2016

Unclassified Maritime Domain Awareness

Boger, Dan; Miller, Scot; Lavoie, Erik; Wreski, Erin

Monterey, California. Naval Postgraduate School

MONTEREY, CALIFORNIA

Unclassified Maritime Domain Awareness

Report Type: Final

Period of Performance: 10/01/2015-10/01/2016

Project PI: Dr Dan Boger, Professor, Chair of Information Sciences

Additional Author/Authors: Scot Miller, Faculty Associate Research, Information Sciences

Student Participation: CDR Erik Lavoie, LCDR Erin Wreski, Network Operations and Technology

Prepared for:
Topic Sponsor: Commander, SEVENTH Fleet
Research Sponsor Organization (if different):
Research POC Name: CAPT Jeffery Bierley, Director, Commander's Initiative Group
Research POC Contact Information: Jeffrey.Bierley@fe.navy.mil, 81-80-1323-2290

EXECUTIVE SUMMARY (3-5 PAGES, 600-800 WORDS)

Project Summary

The maritime domain is an area of significant strategic concern to the United States and its allies. When the need arises, U.S. forces are able to detect and monitor vessels of interest (VOIs) in support of maritime interests throughout the world. However, current maritime domain awareness (MDA) processes lack the ability to provide actionable information in a timely and usable manner. Advances in intelligence, surveillance and reconnaissance (ISR) technology—particularly unclassified data sources, analytical processes and tools—available in the commercial sector could be leveraged to make MDA data more accessible and productive.

The purpose of this research is to establish a concept of operations (CONOPS) that will provide an unclassified maritime common operational picture (COP) with the capability to produce near-real-time shareable information from which all authorized interested parties can benefit. The research focuses on utilizing available unclassified commercial-off-the-shelf (COTS) capabilities to create a scalable and extensible platform that provides intelligence analysts and decision makers the ability to gain additional situational awareness and gather actionable information which can be quickly and easily shared with other service and international partners. Additionally, in an effort to prove the proposed CONOPS will work, the process was attempted utilizing some of these technologies.

Keywords: *Maritime domain awareness, feature recognition, EO satellite imagery, concept of operations, SPOTR, commercial satellite imagery, SeaVision*

Background

The Naval Postgraduate School Information Science Department has proposed a two-year campaign of integrated thesis research designed to explore and develop ideas

relating to the development of an unclassified maritime domain awareness (MDA) concept of operations (CONOPS). U.S. forces are able to detect and monitor the maritime domain in support of maritime interests around the world, but often lack the ability to provide actionable information in a shareable, useable manner. This issue, in particular, is an ongoing Commander Seventh Fleet (C7F) topic of interest due to the complex MDA issues present in their area of responsibility (AOR). The intent of this thesis is to take the first step in the development of a fully implementable CONOPS that leverages recent developments in unclassified commercial-off-the-shelf (COTS) intelligence, surveillance and reconnaissance (ISR) capabilities to build a comprehensive common operational picture (COP). The overarching goal of the COP is to provide the who, when, what and where for maritime vessels of interest (VOIs) adaptable to specific areas of interest (AOIs) so that operators and intelligence analysts, who will infer the why and how, can make informed actionable decisions and/or share data with interested parties.

MDA is defined as “the effective understanding of anything associated with the maritime domain that could impact the security, safety, economy, or environment of the United States” (White House, 2013, p. 2). It encompasses “all areas and things of, on, under, relating to, adjacent to, or bordering on a sea, ocean, or other navigable waterway, including all maritime-related activities, infrastructure, people, cargo, vessels, and other conveyances” (White House, 2013, p. 2). What is happening in the waterways around the world is becoming an increasing concern. Technological advances in recent decades have provided an environment that has allowed the global capital market to grow and open new economic opportunities via complex commerce pathways. The global supply chain is becoming increasingly dependent on interconnected waterways to support these expanding opportunities and, as a result, they have become essential to the United States’ national economy, commerce and security. However, the increasing number of countries and vessels moving freely

through these waterways is creating complex security issues. Harmful and unlawful acts within this increasingly important domain can cause the disruption or destruction of a physical and economic nature to the United States and its partners (White House, 2012). There is no shortage of these threats to national security and economic interests. These include terrorism, criminal activities, piracy, environmental destruction, illegal immigration, and human and drug trafficking to name a few (White House, 2013). The core principles of effective MDA promote a unity of effort through proper information sharing and safeguarding in order to facilitate informed decision making to ensure the safe and timely movements of legitimate commerce (White House, 2013).

When the need arises, U.S. forces are able to identify and track VOIs in support of these maritime interests. However, the means by which this data is collected and processed often does not result in information quickly or in a form that is easily shareable, which can result in lost opportunities. The data often comes from classified sources. Additionally, data persistence is difficult to maintain because it is either too expensive to sustain continuous operation of the sensor and/or there are too few personnel or resources to commit to data and information gathering objectives. This creates a reactionary environment for data analysts and decision makers who would prefer to know and act on the threat before the damage is done.

Findings and Conclusions (to include Process)

The goal of this thesis was to construct an unclassified CONOPS strategy to meet the evolving needs of fleet and operational commanders in the execution of MDA. The CONOPS presented is the result of extensive research into current operational MDA methods and requirements and new or improved ISR technologies. Those findings were used to develop a CONOPS that could produce unclassified data fused from numerous input sources that is low-cost, low bandwidth and easy to use. Having developed a

CONOPS that met those requirements in theory, it was tested to validate its feasibility and flush out the initial imperfections.

The testing methods simulated the recommended process by utilizing the same technologies for data retrieval, processing and display suggested in the CONOPS, DigitalGlobe, SPOTR and SeaVision respectively. The concept behind the initial attempt was to detect, classify and identify a set of non-cooperative vessels using only the unclassified technologies suggested. Due to time and access constraints, however, a complete test of the CONOPS was not possible. The classification, identification and data input steps of testing via the automated system was not completed. The manual method and automated detection results received did expose multiple strengths and weakness of the three subsystems used and the overall CONOPS processes that can be improved upon in future attempts to test and refine the process.

New and evolving maritime threats and concerns require new and creative ways to conduct MDA. The CONOPS presented in this thesis is a simple yet powerful tool that creates a collaborative platform for all concerned entities to share information. It combines cooperative vessel tracking systems already in place with processed data derived from high-resolution commercial satellite imagery to provide data on vessel movements all over the world. Initial testing demonstrated that together these systems can provide a wealth of information in a fraction of the time and cost required by the cumbersome methods used currently. Further development will be required to move the CONOPS from theory to reality, but the capabilities to make the transition exist. Additionally, beyond the new and expanding COTS technologies suggested, the CONOPS provides an avenue for future growth because of its inherent flexibility, scalability and extensibility. Changes in the input sources to SeaVision, a service-orientated application, rarely affect the user. As long as the changes present the user with added benefits and remain easy to use, adoptability and acceptability will not be a concern.

As with any new information platform utilized by operators and analysts, especially one which provides valuable information on the movements of national and foreign assets, there will be some pushback. This will arise from concerns as to the level of information the system provides and who has access to it. This CONOPS provides a means to gather and share public information via a platform that is unclassified from source to display. As long as the information presented in this platform remains of common interest to all users, such as securing borders and the freedom of movement, classification concerns should be minimal. It simply provides a single comprehensive capability that could allow the flow of useful unclassified information between agencies and allies to enable an effective MDA environment beneficial to all.

Recommendations for Further Research

More effort needs to be made to integrate the various technologies together to form the complete COP. The next steps should include importing the imagery-based SPOTR derived track data into SeaVision and maturing the SeaVision application as future capabilities become available.

IMPORT IMAGERY DATA INTO SEAVISION

The most significant hurdle to making the COP a reality is transforming SPOTR derived track data into an acceptable message format for input into SeaVision real time. Certain steps are required to import the current SPOTR contact and tracking information to the SeaVision COP. Along with using the correct image download format, NITFS, the speed of data acquisition and transfer must be increased.

The next challenge to overcome is displaying the SPOTR data on the SeaVision COP. This will require the data to be input into the proper message format. One of the primary reasons SeaVision was selected for the COP display is because it is already built to allow NIEM conformant exchanges (Department of Transportation, n.d.). This means

that SeaVision can quickly assimilate new data sources, including those from new services, other agencies and foreign partners.

TRANSITION TO FUTURE CAPABILITIES

This CONOPS is meant to allow for future growth and expansion providing capabilities beyond data display and correlation if desired. With the proper tools in place, it could be leveraged for social network analysis along with big data analytics and dynamic logic to go beyond the who, what, where and when, but start to answer the why and how. Most COPs in existence today fail to provide information beyond answering the questions of who and where (Arciszewski & De Greef, 2011). Recent advances in big data analytics could provide new ways to further exploit the information this COP provides. With high-level data abstractions and advanced fusion techniques, detection of VOI operating patterns may be detected. With a big data approach, the sources of the unclassified COP could be ingested into a distributed file system to derive big data solutions that recognize such patterns. Analysis of these patterns and social networks can provide suggestions on how monitored vessels match planned or predicted movements or actions. These patterns of life could aid in the determination of activity and intent which would be a breakthrough in data exploitation.

References

Arciszewski, H. F. & De Greef, T. E. (2011). *A smarter common operational picture: The application of abstraction hierarchies to naval command and control*, Presented at the 16th International Command and Control Research and Technology Symposium, Quebec City, 2011. The Hague, The Netherlands: TNO Defense. Retrieved from https://www.researchgate.net/publication/235039633

Boraz, S. C. (2009). Maritime domain awareness: Myths and realities. *Naval War College Review*, *62*(3), 137.

Chinese naval bases. (n.d.). Retrieved February 21, 2017, from http://www.globalsecurity.org/military/world/china/ports.htm

DigitalGlobe. (2014, June 11). U.S. department of commerce relaxes resolution restrictions digitalglobe extends lead in image quality [Press Release]. Retrieved from http://investor.digitalglobe.com/phoenix.zhtml?c=70788&p=irol-newsArticle&ID=1939027

Digital Globe. (2016, 05 February). EV-WHS Desktop user manual. Retrieved from https://evwhs.digitalglobe.com/myDigitalGlobe/login homepage

Digital Globe fact sheet. (2017, January 19). Retrieved from https://evwhs.digitalglobe.com/myDigitalGlobe/login

Faltemier, T., Steinhaeuser, K., Miller, D., & Paradis, L. (2016, June 20). Computer vision for maritime domain awareness [PowerPoint]. Manassas, VA: Progeny Systems Corporation.

Seavision. (n.d.a). FAQ webpage. Retrieved on January 17, 2017 from http://seavision.mda.gov/faq

SeaVision (n.d.b). What is seavision. Retrieved on September 10th, 2016 from http://seavision.mda.gov/about-seavision

Steinhaeuser, K. (2016). SPOTR operational view [Power Point Slides]. Manassas, VA: Progeny Systems Corporation.

U.S. Department of Transportation. (n.d.). Seavision information sheet, version 5.0. Retrieved on 17 February 2017 from http://ec2-107-22-98-244.compute-1.amazonaws.com/sites/default/files/2016-03/SeaVision_v5.06%20(glossy)_0.pdf

Volpe Center. (n.d.) Maritime safety and security information system (MSSIS). Retrieved on 17 February 2017 from https://www.volpe.dot.gov/infrastructure-systems-and-technology/situational-awareness-and-logistics/maritime-safety-and

White House. (2012). *National strategy for global supply chain security (NSGSCS).* Executive Summary. Washington, DC: The White House. Retrieved from https://obamawhitehouse.archives.gov/sites/default/files/national_strategy_for_global_supply_chain_security.pdf

White House. (2013, December). *National maritime domain awareness plan for the national strategy for maritime security*. Washington, DC: The White House. Retrieved from https://obamawhitehouse.archives.gov/sites/default/files/docs/national_maritime_domain_awareness_plan.pdf